THE EFFECT OF RAIN ON THE SNOW COVER [1]

551.578.1 : 551.578.46

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[Utah Agricultural Experiment Station, Logan, Utah, July 11, 1929]

There are several opinions concerning the disposal of rain water which falls on a snow cover. Does it go through the snow as through a porous medium? Does it melt some of the snow crystals as it goes through, or is it absorbed by the snow cover and held until the snow melts? An attempt to answer some of these questions was made by the Utah Agricultural Experiment Station in May, 1928. Experiments were carried out on the Wasatch Plateau at an elevation of 8,700 feet. By these experiments it was sought to determine some of the snow-melting characteristics.

Fluorescein was used as a coloring matter so the path of the water could be traced through the snow. Experiments were conducted on the snow cover during rain storms, after rain storms, and during freezing weather. Some few experiments were conducted using artificial rain in an effort to determine the melting effect of rain.

On May 10, 1928, during a medium downpour of rain fluorescein was placed on the snow cover in an open park. Within 5 minutes the color had reached the ground through 4 feet of snow. The color reached the ground first through tiny crooked paths, indicating there were continuous paths through which the rain water was reaching the ground. The entire mass of snow showed the color more slowly, indicating that a general downward movement of water through the snow was going on.

Fluorescein placed on a level snow surface during clear, warm weather showed some well defined water channels, but in general the downward movement of moisture was quite uniform throughout the entire mass. This indicated that the snow layer was melting from the top as well as from the bottom and that the water from the surface was going down through the porous snow to the ground.

Fluorescein was placed on a level snow surface just prior to freezing temperature. In fact, the thermometer registered quite close to zero centigrade when the color was placed. Twelve hours later the snow column was examined, and it was found that the color had progressed only approximately 3 inches into the snow, showing that with the fall in temperature the water in the snow, which carried the color, was congealed and held in place until higher temperatures melted it again.

Along with this experiment fluorescein was placed on a snow cover on a steep slope to determine if any degree of movement took place down the slope. In the first case the slope was one and one-half to one. The color moved down the slope only 1½ feet, while dropping vertically approximately 3 feet. This indicates that there is not much movement of moisture down the slope through the snow cover. In the second case the slope was flatter, being two to one, in which the color passed vertically downward and then moved along the ground in the snow layer next to the ground about 3 feet in 12 hours. There was no appreciable lateral movement through the snow. The third case was a repetition of the first, on a slope of one and one-half to one, and here the coloring matter moved down the slope about a foot in a vertical drop of 3 feet. These experiments indicate very little movement down the slope through the snow during the process of melting.

In addition to the above field experiments some laboratory experiments were conducted using snow cores 8 inches in diameter and up to 20 inches long. These core were allowed to melt under a constant temperature of 90° F. Fluorescein was placed on each core, and in every case narrow streaks of color preceded the uniform mass of color to the bottom. The coloring matter had entirely disappeared from the snow before the cores were entirely melted, showing that the water carrying the coloring matter had entirely passed out of the snow cores.

To determine the extent to which rain melts the snow cover on which it falls, two snow cores having a diameter of 6.37 inches and depth of 7.25 inches were set up. Colored artificial rain water was applied to these cores through a hand sprinkler. The temperature of water on first core was 78° F. and on the second core 54° F. Water to a depth of 7 inches was sprinkled on each core. Both cores had passed their point of maximum density and the snow was granular and porous. The artificial rain passed to the bottom of the column of snow immediately upon application. It was stored in the bottom of the column until the capillary rise amounted to about 1¼ inches. The water then passed through the snow at practically the same rate it was applied. After applying 7.25 inches depth of water to each core they were allowed to drain for 3 minutes. The snow above the capillary rise took on its original whiteness, indicating that the applied water had passed on through.

In case one, where the water had a temperature of 78° F., more than one-half the snow core was melted. In case two, with a water temperature of 54° F., the core lost only 18 per cent of its original water content.

These few experiments are not claimed to be conclusive, but they do indicate that rain alone plays a minor part in melting the snow cover.

[1] Contribution from Department of Irrigation and Drainage, Utah Agricultural Experiment Station. Publication authorized by Director, July 11, 1929.

THE FREQUENCY OF TROPICAL CYCLONES (WEST INDIAN HURRICANES) THAT CLOSELY APPROACH OR ENTER CONTINENTAL UNITED STATES

551.515 (73)

By ALFRED J. HENRY

Although there have been three major compilations of the purely statistical view of tropical cyclones of the Western Hemisphere during the last twenty and odd years [1] close agreement in the number and frequency of these storms is lacking. This is not surprising in view of the inherent difficulty that arises when attempt is made to use a scale of intensity. No two persons will closely agree upon the allocation of a large number of storms to any common scale. The beginning of the record in each of these publications is different; the storms of the early seventies being omitted, thus: Garriott begins with 1878 and ends with 1900, Fassig begins with 1876 and ends with 1911, and Mitchell begins with 1887 and ends with 1923. While it is true that the record of the early seventies is much less complete than that of subsequent years, nevertheless it is the purpose of the present writer to include it to the end that the record of tropical cyclones

[1] Garriott, E. B., West Indian Hurricanes, Weather Bureau Bulletin H, Washington, D. C., 1900. Fassig, O. L., Hurricanes of the West Indies, Weather Bureau Bulletin X, 19103. Mitchell, C. L., West Indian Hurricanes and Other Tropical Cyclones of the North Atlantic, Mo. Wea. Rev., Supplement No. 24, 1924.

during the life of the Federal weather service may be complete and homogeneous. It developed at the beginning of the study that it would be necessary to examine the entire record of 58 years to insure homogeneity. Considerable difficulty was encountered because of the fact that it was not always possible to distinguish from the printed records between those storms which might be classed as severe tropical cyclones and those that did not possess the distinctive features of a severe tropical storm.

Mitchell realized this necessity and classed the storms listed into three groups as follows: (1) Those of known hurricane intensity, 122 or 51 per cent; (2) doubtful, 57 or 24 per cent; (3) not of hurricane intensity, 60 or 25 per cent. His criterion of intensity was a wind velocity of at least 60 m. p. h. I have adopted this criterion and added two others, first a minimum pressure of at least 29.50 inches, sea level and second the origin of the storm must have been below the parallel of 30° north latitude, so that roughly speaking, a storm must have had a minimum pressure of half an inch below normal sea level pressure and a velocity equal to force 10 to 12 Beaufort scale and have originated below 30° north latitude. Using the criteria first named (1 and 2) many extra tropical cyclones would qualify. The third criterion seems necessary to establish the right to be classed as a tropical cyclone.

The result of applying these tests to the data in hand was to reduce, somewhat, the number of tropical cyclones hitherto reported as having visited continental United States or having approached close enough thereto to warrant the display of storm warnings along the Atlantic seaboard. Following is a comparison with the figures previously reported: Garriott listed 95 storms during the 23 years 1878–1900, Fassig listed 143 storms during the 36 years 1876–1911, Mitchell listed 239 storms during the 37 years 1887–1923. The last named, however, classed as true hurricanes but 122 out of his total of 239 storms.

For the like period of years in each case I have listed 19 less storms than Garriott, 38 less than Fassig, and 14 less than Mitchell considering only his storms of true hurricane intensity.

In my count I have consulted some of the unpublished manuscript records of Weather Bureau stations for the early seventies and subsequent years, the printed Monthly Weather Reviews back to 1873, and such other collateral evidence as can be found in the Weather Bureau Library.

It is by no means a simple matter to determine from the printed and manuscript records in each case whether or not the storm should be classed as of true hurricane intensity; in the case of reports from vessels at sea whenever a wind force of 10 to 12 Beaufort was reported that fact was considered as ample evidence of the nature of the storm. At land stations in the interior of the continent at some distance from the storm center it was necessary to consider the evidence of destructive wind force as manifested in the damage and destruction of buildings and the blowing down and twisting off of trees near the ground.

During the course of the study evidence of the twisting character of the winds in a few severe storms was found. The almost total destruction of substantially built structures in Porto Rico during the prevalence of the hurricane of September 10–20, 1928, as shown by photographs exhibited to the writer by Doctor Fassig, during his recent visit to Washington, D. C., raises a reasonable doubt as to whether the destruction was due to a steady blow or to shifting gusts from varying directions; since however no measures are available as to either the force or direction of the gust velocity a conclusion is not possible. A case from southeast Georgia during the severe hurricane of August 28, 1881, has been reported where a path of about 16 miles in length of total destruction of the trees in a fairly mature forest was associated with zones on either side of not the slightest evidence of the presence of destructive winds. Other cases of the action of tornado-like winds have come to notice.

Another peculiarity of tropical cyclones is their habit of waxing and waning in energy at more than one point in their course.

The store of energy in a tropical storm seems to be rather easily dissipated. It is the rule all over the world that they either wholly dissipate or greatly diminish in energy on striking land, particularly when their onward course is obstructed by high hills or low mountains. Tropical cyclones entering the mainland of the United States east of the mouth of the Mississippi on the second branch of their course are a partial exception to the general rule since such storms may move northeastward parallel with the coast but over land and retain a measure of the intensity of a true hurricane; several cases are known of the central calm area persisting to and above the parallel of 40° north latitude. The residual depression that sometimes persists after striking the coast may reach the lake region and there merge in the general easterly drift in that region. A notable exception to all rules is the case of the tropical cyclone of September 28–29, 1896. In the morning of the 28th it was centered over southeastern Georgia with a central isobar of 20.70 inches. Its previous history was somewhat obscure but it was later tracked to about W. long. 65°. During the daylight hours of the 28th the cyclone moved rapidly northward, pressure at its center decreasing about half an inch; it was not associated with much heavy rainfall but hurricane winds developed by nightfall, a maximum velocity of 66 m. p. h. being recorded at Washington, D. C. One person was killed by falling walls in Washington and 113 elsewhere, mostly in Florida and Georgia. The property loss aggregated about $7,000,000.

In Table 1 I give the number of tropical storms that have been reported as having entered or approached the Continent of North America from tropical seas each year from 1871 to 1928. The well-known list of Poey was used, after storms of undoubted extra-tropical origin had been deleted. The inclusion of these storms in the original list seems to have been due to the fact that they were reported by W. C. Redfield, the pioneer student of tropical cyclones in the Western Hemisphere. Redfield in his effort to establish the rotary character of storms drew his examples from both tropical and extra-tropical storms and his listing of a storm was not questioned. It is clear from a reading of his original papers that he never distinguished between the two classes of storms.

I have supplemented Poey's list so as to bridge the gap between 1855 and 1870, both inclusive, from various sources as indicated.

TABLE 1.—*Chronological list of tropical cyclones that approached or touched the United States, 1722 to 1870*

[Abstracted from Table chronologique de quatre cents cyclones qui ont sévi dans les Indes Occidentales et dans l' Océan Atlantique Nord depuis 1493 jusqu'en 1855, by Andrès Poey, 1862, with additions. Intensity of storms mostly indeterminate]

TABLE 1.—*Chronological list of tropical cyclones that approached or touched the United States, 1722 to 1870*—Continued

[Abstracted from Table chronologique de quatre cents cyclones qui ont sévi dans les Indes Occidentales et dans l' Océan Atlantique Nord depuis 1493 jusqu'en 1855, by Andrès Poey, 1862, with additions. Intensity of storms mostly indeterminate]

Dates	Localities	Authorities
Aug. 28, 1722	Jamaica, Carolinas	Schomburgk[1] Edwards,[2] vol. 1, p. 197; Tegg,[3] pp. 149, 157; Rees's Encyclopedia (article on "Hurricane"); Evans [4]; Johnston [5]; Southey,[6] vol. 2, p. 231; Robert Renny, History of Jamaica, p. 48, London, 1807; G. W. Bridges, Annals of Jamaica, p. 352, London, 1828; Henderson, Almanac of Jamaica, p. 34, 1852; Moreau de Jonnès' ; Aikman's Almanac, p. 24, Jamaica, 1816.
August, 1728	Carolinas	Redfield's MSS.; Tegg,[3] p. 157.
September, 1752	Charleston, S. C.	Redfield's MSS.
Sept. 15, 1752	do	Blodgett, Climatology, p. 397.
Sept. 15, 1753	Charleston, S. C.	Tegg,[3] p. 134.
1756	Coast Georgia, St. Simons Island.	Lyell (second visit to United States).
1757	Florida to Boston, Mass.	Warden,[8] vol. 1, p. 155.
Aug. 23, 1758	Barbados, South Carolina.	Tegg,[3] pp. 157, 162.
May 4, 1761	Charleston, S. C.	Tegg,[3] p. 157.
June 1, 1761	do	Phillips, Barbados Almanac, 1839, p. 123.
Sept. 11, 1766	Virginia	Redfield's MSS.
Oct. 22, 1766	Pensacola, Fla.	Schomburgk [1]; Southey,[6] vol. 2, p. 390; Evans [4]; Johnston.[5]
Aug. 30, 1769	East of Florida	Redfield's MSS.
Oct. 29, 1769	do	Bernard, Histoire du Roman; Redfield's MSS.; Tegg,[3] p. 132.
June 6, 1770	Charleston, S. C.	Perrey. (NOTE.—Name of publication not given.)
Aug. 31–Sept. 3, 1772	Southern Louisiana along the coast.	Blodgett, Climatology, p. 397.[18]
August, 1773	Boston, Mass.	Tegg,[3] p. 157.
1779	New Orleans, La.	Dunbar, Transactions of the American Society, Philadelphia, vol. 6, second series. Philadelphia, 1804.
Oct. 7–10, 1778	New Orelans, La. (near).	Blodgett, Climatology, p. 397.[18]
Aug. 18, 1779	do	Do.
Aug. 25, 1780	St. Kitts, New Orleans, La.	Dunbar, idem.; Redfield's MSS.
Oct. 3–5, 1780	Gulf of Florida	Blodgett, Climatology,[18] p. 397.
Oct. 10–18, 1780	Barbados, Jamaica, Havana.	Blodgett, Climatology, p. 397, The Great Hurricane of 1780.
Aug. 10, 1781	North Carolina	Redfield's MSS.
Sept. 22–24, 1785	Carolinas and Virginia.	New Haven Gazette, Oct. 13.
Aug. 29, 1786	United States	Pennsylvania Packet, Philadelphia, Jan. 22, 1787.
July 30, 1787	do	Redfield's MSS.
Aug. 15, 1787	Florida	Do.
Sept. 19, 1787	United States	Do.
July 22, 1788	do	Do.
Aug. 19, 1788	do	Do.
Sept. 19, 20, 1788	do	Do.
September, 1797	Charleston, S. C.	Blodgett, Climatology,[18] p. 397.
Sept. 3–9, 1804	Martinique, islands of the Caribbean Sea, coast South Carolina and Georgia.	Schomburgk[1]; Edwards[2]; Warden,[8] vol. 1, p. 155; Purdy,[9] p. 102; Mease, Geological Account of the United States, p. 100; Medical Repertory, Hex., vol. 1, and Hex. II, vol. 2, p. 354; Evans [4]; Moreau de Jonnès [7]; Redfield, Route IV.[16]
Oct. 4, 1804 [a]	Savannah, Ga.	Redfield's MSS.; Burr's Letters.
Oct. 9, 1804 [a]	United States	Redfield's MSS.; New York Herald, Oct. 24.
Sept. 10, 1811	Charleston, S. C.	Blodgett, Climatology,[18] p. 398—Very violent.
Aug. 19, 1812	New Orleans, La.	Redfield's MSS.
Aug. 27, 1813	Charleston, S. C.	Blodgett, Climatology,[18] p. 398.
July 1, 1814	do	Do.
Sept. 18–24, 1815	Coast New York and New England.	Do.
Sept. 1, 1821	Turks Island to Long Island.	Schomburgk;[1] Purdy,[9] p. 102; Reid,[10] pp. 11–15, Chart I; Espy,[11] pp. 209–228; Evans;[4] Johnston;[5] Redfield, Silliman's Journal (The American Journal of Science and Arts), 2d series, vol. 20, pp. 24–27; Redfield;[12] Redfield, Route VIII.[16]
Sept. 25, 1821 [a]	New Haven, Conn.	Tegg,[3] p. 159.
July 11, 1822	Mobile, Ala.	New York Gazette; Redfield's MSS.
1824	Coast of Georgia	Blodgett, Climatology,[18] p. 398.
July 30, 1827	North Carolina	Perrey. (NOTE.—Name of publication not given.)
Aug. 17–28, 1827	Windward Islands to Porpoise Bank (37° 43' N., 75° 21' W.).	Schomburgk;[1] Purdy,[9] p. 98; Evans;[4] Almanach de Saint-Christophe; Perrey (see note immediately above); Redfield;[12] Redfield, Route III.[16]
July 24, 1829	Boston, Mass.	Purdy,[9] p. 98; Thomson,[13] p. 416; Boston Gazette.
Aug. 19–24, 1830	Martinique	Purdy,[9] p. 102; Reid,[10] pp. 127–132.
Aug. 10–19, 1830	United States coast, Florida to Norfolk, Va.	Blodgett, Climatology,[18] p. 398.
Sept. 29–Oct. 2, 1830	West Indies to Grand Bank.	Do.[18]
June 10, 1831	Florida	Redfield's MSS.
Aug. 10–17, 1831	Gulf coast	Redfield, Track II.
September, 1834	Mouth of Rio Grande	Blodgett, Climatology.[18]
Aug. 12–18, 1835	Antigua, Cuba, Galveston.	Redfield, Route V;[12] Schomburgh;[1] Piddington,[14] p. 144; Reid,[10] p. 43; Evans;[4] Johnston.[5]
Aug. 31, 1837	St. Mark, Fla.	Redfield;[16] Reid,[10] pp. 119–124.
Aug. 31–Sept. 3, 1837.	Apalachicola, Fla.	Reid,[10] pp. 124, 126.
Sept. 27–Oct. 10, 1837.	Gulf of Mexico	Reid,[10] pp. 133–145; Reid,[15] pp. 13, 209; Piddington,[14] p. 144; Redfield, Route XV.[16]
Nov. 5, 1839	Galveston, near St. Louis Island, Gulf of Mexico.	Evans.[4]
Oct. 3–6, 1841	Nantucket	Royal Gazette, Bermuda, Oct. 26; New York Journal of Commerce, Oct. 11.
Aug. 30–Sept. 9, 1842.	Due west across Florida to Tampico.	Blodgett, Climatology,[18] p. 399.
Oct. 2–9, 1842	Gulf of Mexico, Atlantic coast south of Charleston.	Do.[18]
July 12, 1842	Ocracoke, Cape Hatteras, N. C.	Evans;[4] Johnston.[5]
Oct. 13, 1843	Florida	Moniteur Belge, Oct. 26.
Aug. 4–6, 1844	Mouth of Rio Grande	Blodgett, Climatology,[18] p. 399.
Oct. 4–7, 1844	Cuba, Key West, Charleston.	Do.[18]
Oct. 12, 1845	Florida Channel	Johnston;[5] Evans.[4]
Oct. 6–18, 1846	Cuba, United States	Desiderio Herrera. Memoria sobre los Huracanes en la Isla de Cuba. Habana, 1847; Schomburgk;[1] Redfield, Route XX;[16] Piddington,[14] pp. 134, 193, 195; Royal Gazette, Bermuda, Oct. 20, Nov. 3, 17, and 24; Thomson,[13] p. 419; Reseña de los Estragos del Huracan de 1846; Piddington,[17] p. 155; New York Daily News, Dec. 21; New York Evening Mail, Nov. 6; Mission Record, vol. 2, p. 19; Diario de la Habana, Oct. 15, 20; Moniteur Belge, Nov. 22.
Aug. 22–Sept. 5, 1848.	Off Florida coast	12—Track XXI.
Aug. 16–28, 1851	St. Mark, Fla., St. Kitts, St. Thomas, Cuba.	Almanach de Saint-Christophe, 1855; New York Herald, Oct. 23; Royal Gazette, Bermuda, Sept. 2; Indépendance Belge, Sept. 28; Redfield, Route XXII.[16]
Oct. 9, 1852	St. Mark, Fla.	New York Herald, Oct. 20 and 23.
Aug. 30–Sept. 11, 1853.	Cape Verde, Hatteras, N. C.	Redfield, Route XXIV;[16] Redfield.[16]
Sept. 6–14, 1854	Atlantic coast, Florida to New England.	Blodgett, Climatology [18] U. S., p. 400.
Aug. 10, 1856	Louisiana coast	Blodgett, Climatology,[18] p. 400. This was the storm celebrated in story by Lafcadio Hearn in "A memory of Last Island." The Warner Library, Harper Bros., vol. 12, p. 7, 132.
Aug. 2–Sept. 2, 1856	Gulf coast and thence northeast.	Blodgett, Climatology,[18] p. 400.
Oct. 22, 1865	Calcasieu, La., coast	Mo. Wea. Rev., 49:456. Lowest barometer at Habana, 28.78 in.
Oct. 2–3, 1867	Galveston-Virgin Islands.	Mo. Wea. Rev.,[20] 49:456 and Bulletin H, H. p. 58.
Oct. 19–20, 1870	Pinar del Rio	Wea. Bu. Bulletin H,[19] p. 58. Lowest barometer, Habana, 29.32 in.
Oct. 7–8, 1870	Habana-Matanzas	Lowest barometer,[19] 29.38, Wea. Bu. Bull. H, p. 58.

[a] Probably a duplicate.

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TABLE 2.—*Frequency of tropical cyclones (West Indian hurricanes), 1871–1928*

Year	June	July	August	September	October	November	Total	Smoothed numbers
1871	1 (?)		2		1 (?)		4 (?)	
1872							0	1.5
1873			1		1		2	1.2
1874				1			1	1.2
1875				1			1	1.2
1876				1	1		2	2.0
1877				2	1		3	2.7
1878				1	2		3	2.7
1879			1		1		2	2.5
1880			3				3	2.5
1881			1	1			2	2.2
1882				1	1		2	2.5
1883			2	1	1		4	3.0
1884				1	1		2	2.5
1885			1	1			2	3.5
1886	2		4	1	1		8	6.5
1887			3	3	2		8	7.7
1888			1	3	2	1	7	6.7
1889			1	2	2		5	4.5
1890			1				1	4.2
1891		1	2	3	4		10	6.0
1892			1	1	1		3	6.2
1893	1	1	4	1	2		9	6.5
1894			1	1	3		5	5.0
1895					1		1	2.7
1896		1		3			4	2.2
1897							0	1.7
1898			1	2			3	2.2
1899			1	1	1		3	2.5
1900				1			1	2.0
1901		1	2				3	2.0
1902					1		1	2.2
1903		1	1	2			4	3.2
1904				1	2	1	4	3.5
1905				1	1		2	2.7
1906				2	1		3	2.0
1907							0	1.5
1908		1		2			3	2.5
1909		1	1	1	1		4	3.2
1910				1	1		2	2.2
1911			1				1	1.7
1912				1	1	1	3	1.7
1913							0	0.7
1914							0	0.7
1915				3			3	4.0
1916		3	4		2	1	10	6.2
1917				2			2	4.2
1918			1	2			3	2.5
1919				2			2	2.2
1920				2			2	2.7
1921	1			3	1		5	4.5
1922			3	2	1		6	5.2
1923				3	1		4	4.7
1924			2	1	1	1	5	4.2
1925			1	1		1	3	4.2
1926		1	2	2	1		6	4.0
1927			1				1	3.0
1928			3	1			4	
Sum	5	11	53	68	44	6	187	

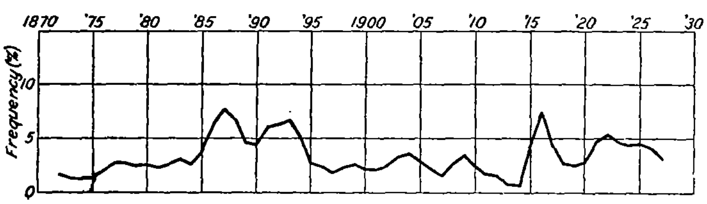

FIGURE 1.—Frequency of tropical cyclones, 1871–1928

I have plotted the smoothed annual number in Table 2 to form the curve in Figure 1. The smoothing process $\frac{(a+2b+c)}{4}$ tends to shift the epochs of maximum or minimum a year, or more, in extreme cases ahead or behind the true date and to reduce the amplitude of the oscillations from year to year; thus the greatest number of storms in any one year occurred in 1891 and 1916. In the first named the maximum was preceded by a year with but a single storm and followed with a year having but three, hence the smoothed value comes out as seven and the year of maximum for the three years is displaced forward to 1893. The chief maximum, 3-year periods considered, occurred in 1886–1888, but the total number of storms in any one of these years was not so great as in 1891 or 1916. There also seems to have been a secondary maximum in the three years 1921–1923. No storms of hurricane intensity occurred in 1907, 1913, and 1914.

DISCUSSION

By Dr. O. L. FASSIG

One interesting result of your list is fixing the culmination of the storm period in September, with August and October nearly equal in storm frequency and again July and November.

I have just completed a study of hurricanes affecting Porto Rico. The results are shown in the accompanying chart (fig. 2). You will see that our storms are also decidedly most frequent in September. I have endeavored to classify Porto Rican storms on a basis of intensity as affecting Porto Rico—dividing them into three classes. Class A includes all storms whose centers passed directly

YEAR / MONTH	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL
1899								A	C				2
1900								C	C				2
01							C						1
02													
03													
04													
05													
06									B				1
07													
08									C				1
09								B					
10									B				
11													
12													
13													
14													
15								B					1
16								B		C			2
17									C				1
18													
19									C				1
20													
21									C				1
22									C				1
23													
24								C					1
25													
26							B		C				2
27													
28									A				1
SUMS							2	6	11	1			20
MEANS (% OF TOTAL ANNUAL)							10	30	55	5			

INTENSITY
CLASS A - GENERALLY DESTRUCTIVE.
CLASS B - LOCALLY DESTRUCTIVE WITH BENEFICIAL RAINS.
CLASS C - LIGHT LOCAL LOSSES WITH BENEFICIAL RAINS.
CLASS A, 10%
CLASS B, 30%
CLASS C, 60%

FIGURE 2.—Distribution of tropical cyclones in Porto Rico

over the island and embraced the entire island within the central area of hurricane winds; of this class there were only two in 30 years, namely 1899 and 1928. Class B, numbering six storms, includes all storms in which some portion of Porto Rico was within the area of hurricane winds—i. e., winds of 75 miles or more per hour. In Class C, Porto Rico fell entirely outside the central area of hurricane winds, but within the area of moderately high winds accompanied by heavy rains. Class C may be called beneficial hurricanes, as the economic value of the rainfall far exceeded all losses by wind.

During the period from 1899 to 1930, Porto Rico had 2 overwhelmingly destructive storms; 6 storms with heavy local losses, combined with beneficial general